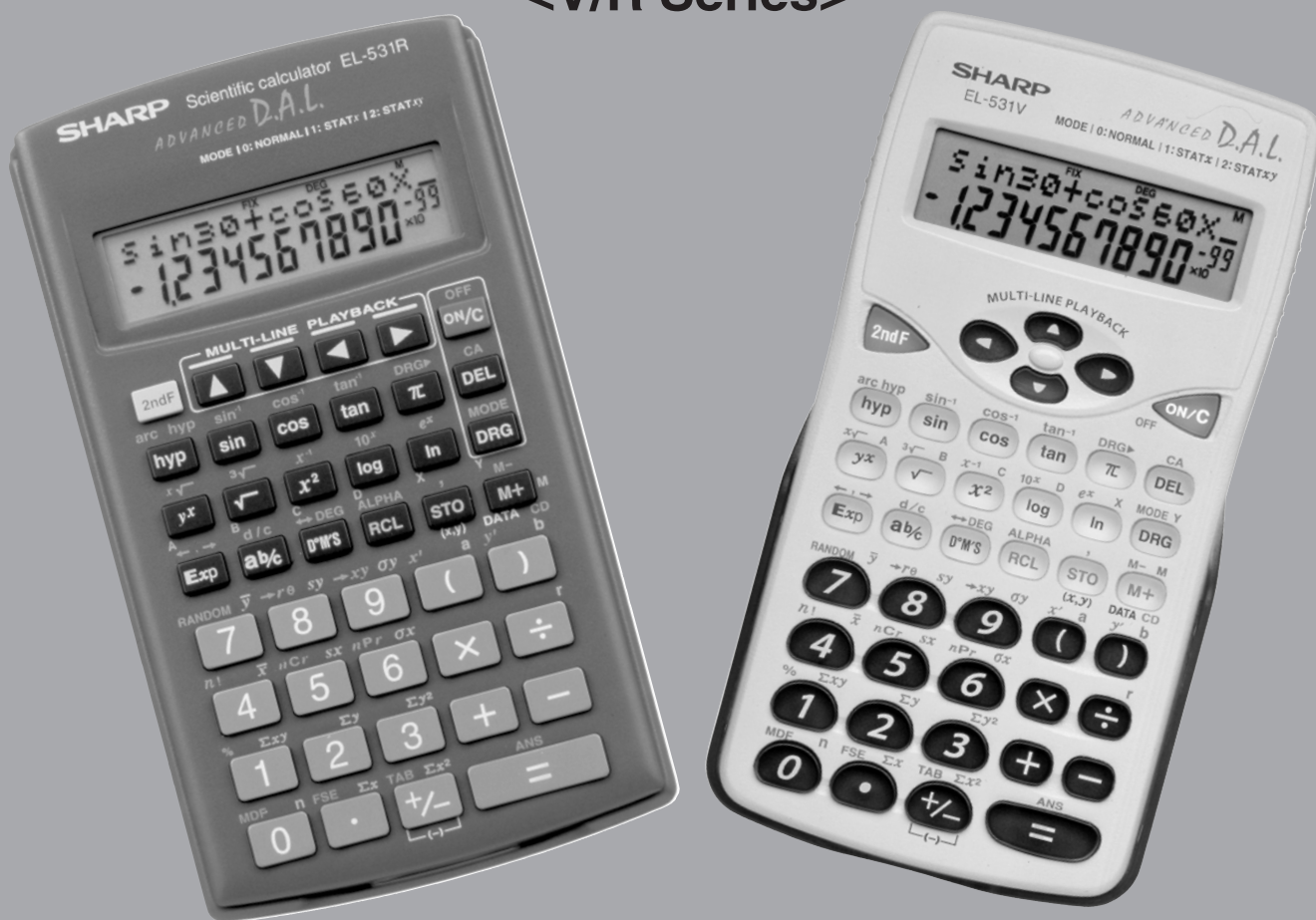# SCIENTIFIC CALCULATOR OPERATION GUIDE

<V/R Series>

SHARP

CONTENTS

How to Operate

≈Read Before Using≈

This operation guide has been written based on the EL-531V, EL-509V, EL-531VH, and EL-509VH models. Some functions described here are not featured on other models. In addition, key operations and symbols on the display may differ according to the model.

1. KEY LAYOUT
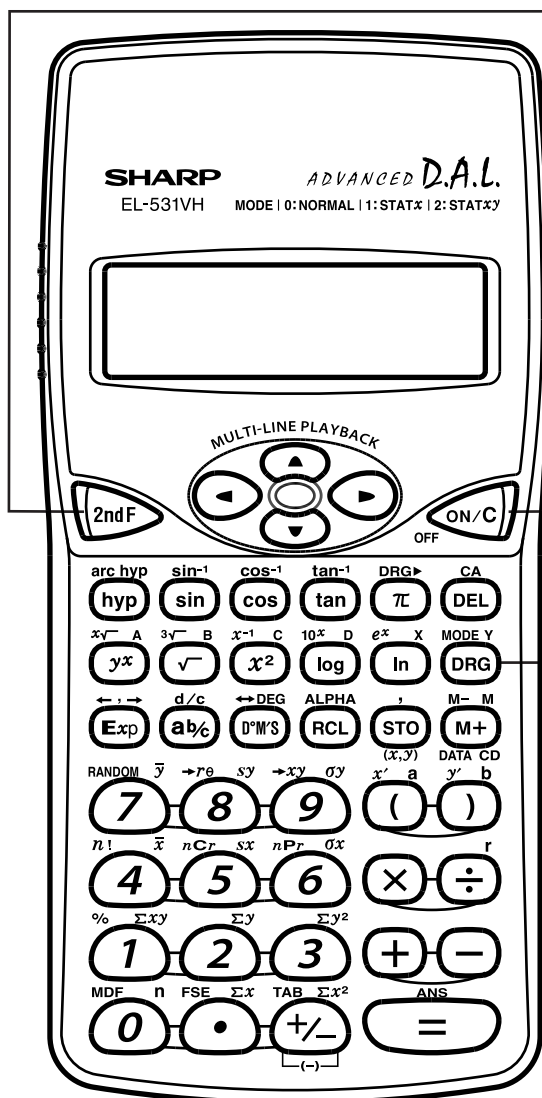
2nd function key

Pressing this key will enable the functions written in yellow above the calculator buttons.

ON/C, OFF key

Direct function   2nd function

[ON/C]   [2ndF] [OFF]

\<Power on\>   \<Power off\>

Written in yellow above the ON/C key

Mode key

This calculator can operate in three different modes as follows.

\<Example\>

[Normal mode]

[2ndF] [MODE] [0]

•Mode = 0; normal mode for performing normal arithmetic and function calculations.

[STAT-1 mode]

[2ndF] [MODE] [1]

•Mode = 1; STAT-1 mode for performing 1-variable statistical calculations.

[STAT-2 mode]

[2ndF] [MODE] [2]

•Mode = 2; STAT-2 mode for performing 2-variable statistical calculations.

2. RESET SWITCH ⊚ RESET

If the calculator fails to operate normally, press the reset switch on the back to reinitialise the unit. The display format and calculation mode will return to their initial settings.

NOTE:
Pressing the reset switch will erase any data stored in memory.

Reset switch

3. DISPLAY PATTERN

Display format indicator (FII, SCI, ENG)

Hyperbolic symbol (HYP)

Alphabet symbol (ALPHA)

Angular unit indicator (DEG/RAD/GRAD)

2ndF symbol

Memory symbol

Appears when the entire equation cannot be displayed.

← 2ndF HYPALPHA   FIXSCIENG   DEGRAD STAT   M →

sin30+cos60=

1.207106781 X10 ‾18̅

Appears when the entire equation cannot be displayed.

Equation display line

Numeric display line (mantissa + exponent)

Exponent display

Minus symbols

The actual display does not appear like this.
This illustration is for explanatory purposes only.

4. DISPLAY FORMAT AND DECIMAL SETTING FUNCTION

For convenient and easy operation, this model can be used in one of four display modes.
The selected display status is shown in the upper part of the display (Format Indicator).
Note: If more 0's (zeros) than needed are displayed when the ON/C key is pressed, check whether or not the calculator is set to a Special Display Format.

- Floating decimal point format (no symbol is displayed)
  Valid values beyond the maximum range are displayed in the form of a [10-digit (mantissa) + 2-digit (exponent)]

- Fixed decimal point format (FIX is displayed)
  Displays the fractional part of the calculation result according to the specified number of decimal places.

- Scientific notation (SCI is displayed)
  Frequently used in science to handle extremely small or large numbers.

- Engineering scientific notation (ENG is displayed)
  Convenient for converting between different units.

<Example> Let's compare the display result of [10000 ÷ 8.1 =] in each display format.

Initial display

(specifies normal mode)

| DEG |
| 0 |

10000 ÷ 8.1 =

| DEG |
| **10000÷8.1=** |
| 1234.567901 |

(normal mode)

| 2ndF FSE 2ndF TAB 3 |

| FIX   DEG |
| **10000÷8.1=** |
| 1234.568 |

(FIX mode TAB = 3)

Keys	Display
2ndF FSE	$10000 \div 8.1 =$ **SCI** **DEG** 1.235×10^{03} (SCI mode)
2ndF FSE	$10000 \div 8.1 =$ **ENG** **DEG** 1.235×10^{03} (ENG mode)
2ndF FSE	$10000 \div 8.1 =$ **DEG** 1234.567901 (normal mode)

5. EXPONENT DISPLAY

The distance from the earth to the sun is approx. 150,000,000 (1.5×10^{8}) km. Values such as this with many zeros are often used in scientific calculations, but entering the zeros one by one is a great deal of work and it's easy to make mistakes.
In such a case, the numerical values are divided into mantissa and exponent portions, displayed and calculated.

<Example> What is the number of electronics flowing in a conductor when the electrical charge across a given cross-section is 0.32 coulombs. (The charge on a single electron = 1.6×10^{-19} coulombs).

Keys	Display
0.32 ÷	**DEG** $0.32 \div \_$ $0.$
1.6 **Exp** 19	**DEG** $0.32 \div \_$ 1.6×10^{19}
=	**DEG** $0.32 \div 1.6E19 =$ $2. \times 10^{-20}$

4

6. ANGULAR UNIT

Angular values are converted from DEG to RAD to GRAD with each push of the DRG key. This function is used when doing calculations related to trigonometric functions or coordinate geometry conversions.

Degrees (DEG is shown at the top of the display)
A commonly used unit of measure for angles. The angular measure of a circle is expressed as 360°.

Radians (RAD is shown at the top of the display)
Radians are different than degrees and express angles based on the circumference of a circle. 180° is equivalent to π radians. Therefore, the angular measure of a circle is 2π radians.

Grads (GRAD is shown at the top of the display)
Grads are a unit of angular measure used in Europe, particularly in France. An angle of 90 degrees is equivalent to 100 grads.

The relationships between the three types of angular units can be expressed as right:

$$90° \text{ (DEG)} =$$
$$\pi/2 \text{ (RAD)} =$$
$$100 \text{ (GRAD)} =$$
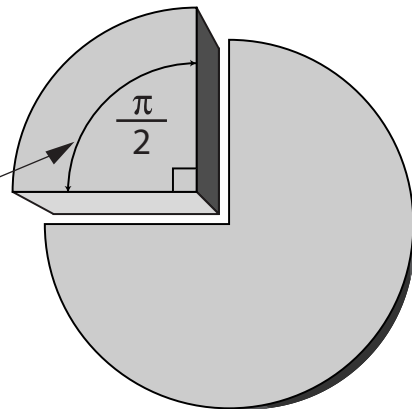
\<Example\> Check to confirm 90 degrees equaling $\pi/2$ radians equaling 100 grads. (π=3.14159...)

Angular indicator

Operation	Display
ON/C **DRG** ······· **DRG** (in DEG mode)	DEG 0.
90 **2ndF** DRG▶	90▸RAD RAD 1.570796327 ($\pi/2$)
2ndF DRG▶	ANS▸GRAD GRAD 100.
2ndF DRG▶	ANS▸DEG DEG 90.

5

≈Function and Key Operation≈

ON/OFF, Entry Correction Keys

ON/C   OFF   CA
▲   ▼   ◀   ▶   DEL
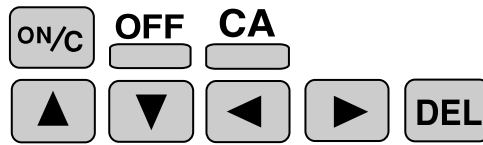
ON/C   Turns the calculator on or clears the data. It also clears the contents of the calculator display and voids any calculator command; however, coefficients in 3-variable linear equations and statistics, as well as values stored in the independent memory in normal mode, are not erased.

OFF   Turns the calculator off.

CA   Clears all internal values, including coefficients in 3-variable linear equations and statistics. Values stored in memory in normal mode are not erased.

▲ ▼   These arrow keys are useful for Multi-Line playback, which lets you scroll through calculation steps one by one. (refer to page 8)

◀ ▶ DEL   These keys are useful for editing equations. The ◀ key moves the cursor to the left, and the ▶ key moves the cursor to the right. The DEL key deletes the symbol/number at the cursor. (refer to page 8)
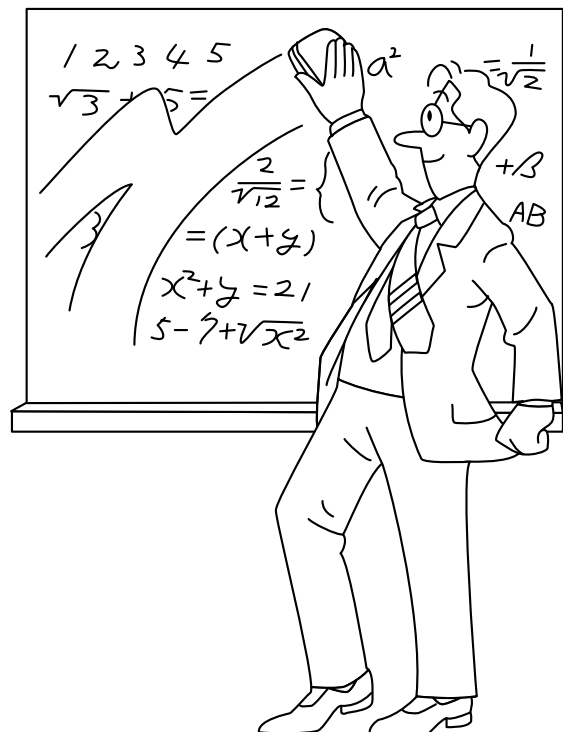
Data Entry Keys ● +/– π Exp

0 to 9 Numeric keys for entering data values.

● Decimal point key. Enters a decimal point.

+/– Enters minus symbol or sign change key.
Changes positive numbers to negative and negative numbers to positive.

π Pressing π automatically enters the value for π (3.14159...).
The constant π, used frequently in function calculations, is the ratio of the circumference of a circle to its diameter.

Exp Pressing this key switches to scientific notation data entry.

\<Example\> Provided the earth is moving around the sun in a circular orbit, how many kilometers will it travel in a year?

* The average distance between the earth and the sun being 1.496×10^8 km.

Circumference equals diameter x π; therefore,
$1.496 \times 10^8 \times 2 \times \pi$

<u>Operation</u>   <u>Display</u>

1   ●   496   Exp   8

```
                    DEG
            1.496 ×10^08
```

×   2   ×   π   =

```
1.496E08x2xπ      DEG
    939964522.
```

Random <u>RANDOM</u>

<u>RANDOM</u> Generates random numbers.
Random numbers are three-decimal-place values between 0.000 and 0.999. Using this function enables the user to obtain unbiased sampling data derived from random values generated by the calculator.

<Example>

2ndF <u>RANDOM</u> =   0.∗∗∗ (a random number has been generated)

APPLICATIONS:
Building sample sets for statistics or research.

Modify MDF

MDF

Function to round calculation results.
Even after setting the number of decimal places on the display, the calculator performs calculations using a larger number of decimal places than that which appears on the display. By using this function, internal calculations will be performed using only the displayed value.

\<Example\> FIX mode TAB = 1 (normal calculation)

5 ÷ 9 = 0.6 (internally, 0.5555...)

× 9 = 5.0

Rounded calculation (MDF)

5 ÷ 9 = 0.6 (internally, 0.5555...)

2ndF MDF (internally, 0.6)

× 9 = 5.4

> APPLICATIONS:
> Frequently used in scientific and technical fields, as well as business, when performing chained calculations.

Basic Arithmetic Keys, Parentheses

<kbd>+</kbd> <kbd>−</kbd> <kbd>×</kbd> <kbd>÷</kbd> <kbd>=</kbd> <kbd>(</kbd> <kbd>)</kbd>
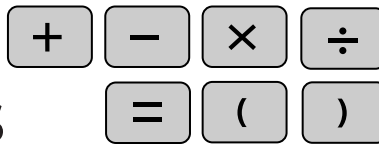
<kbd>+</kbd> <kbd>−</kbd> <kbd>×</kbd> <kbd>÷</kbd> The four basic operators. Each is used in the same way as a standard calculator:
+ (addition), − (subtraction), x (multiplication), and ÷ (division).

<kbd>=</kbd> Finds the result in the same way as a standard calculator.

<kbd>(</kbd> <kbd>)</kbd> Used to specify calculations in which certain operations have precedence. You can make addition and subtraction operations have precedence over multiplication and division by enclosing them in parentheses.

Percent %

% For calculating percentages. Four methods of calculating percentages are presented as follows.

1) $**1**25 increased by **1**0%…**1**37.5

125 ⊕ 10 **2ndF** %

	DEG
125+10%	
	137.5

2) $**1**25 reduced by 20%…**1**00

125 ⊖ 20 **2ndF** %

	DEG
125-20%	
	100.

3) **1**5% of $**1**25…**1**8.75

125 ✕ 15 **2ndF** %

	DEG
125x15%	
	18.75

4) When $**1**25 equals 5% of X , X equals…2500

125 ÷ 5 **2ndF** %

	DEG
125÷5%	
	2500.

Inverse, Square, xth Power of y, Square Root, Cube Root, xth Root of y

x^{-1} x^2 y^x

$\sqrt{}$ $\sqrt[3]{}$ $\sqrt[x]{}$

---
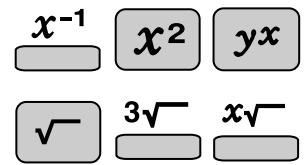
x^{-1} Calculates the inverse of the value on the display.

x^2 Squares the value on the display.

y^x Calculates exponential values.

$\sqrt{}$ Calculates the square root of the value on the display. (The EL-506R/520R need to press 2ndF key first)

$\sqrt[3]{}$ Calculates the cube root of the value on the display.

$\sqrt[x]{}$ Calculates the xth root of y.

<Example>
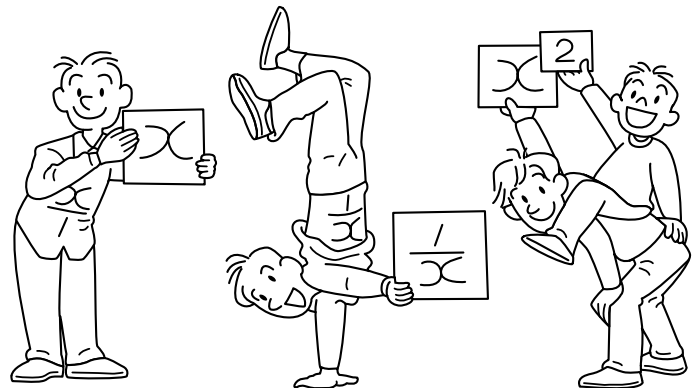
Operation	Display
2 $\times$ 2 $\times$ 2 $\times$ 2 =	2x2x2x2= DEG *16.*
2 y^x 4 =	2^4= DEG *16.*
4 2ndF $\sqrt[x]{}$ 16 =	4x√16= DEG *2.*

10 to the Power of x, Common Logarithm [log] 10^x
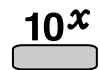
10^x   Calculates the value of 10 raised to the xth power.

log   Calculates logarithm, the exponent of the power to which 10 must be raised to equal the given value.

<Example>

Operation	Display
[2ndF] [10^x] 3 [=]	DEG **10^3=** *1000.*
[log] 1000 [=]	DEG **log1000=** *3.*
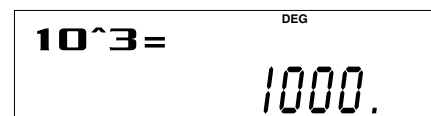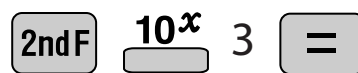
e to the Power of x,
Natural Logarithm [In] e^x
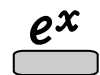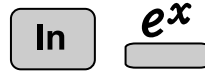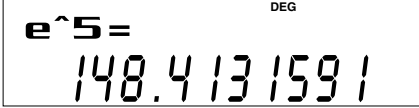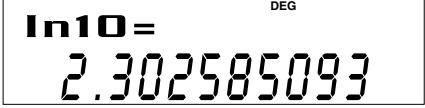
e^x Calculates powers based on the constant e (2.718281828).

[In] Computes the value natural logarithm, the exponent of the power to which e must be raised to equal the given value.

<Example>

Operation	Display
[2ndF] e^x 5 [=]	e^5= DEG 148.4131591
[In] 10 [=]	ln10= DEG 2.302585093

Factorials $n!$

$n!$

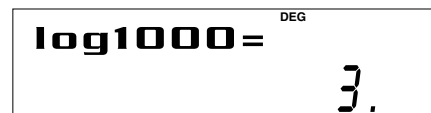The product of a given positive integer n multiplied by all the lesser positive integers from 1 to n-1 is indicated by n! and called the factorial of n.

\<Example\>

Operation

7 [2ndF] [$n!$] [=]

Display

7!=
                    DEG
            5040.

c.f
n! = 1 x 2 x 3 x …xn

APPLICATIONS:
Used in statistics and mathematics. In statistics, this function is used in calculations involving combinations and permutations.

Permutations, Combinations $n\mathbf{P}r$ $n\mathbf{C}r$

$n\mathbf{P}r$
This function finds the number of different possible orderings in selecting r objects from a set of n objects. For example, there are six different ways of ordering the letters ABC in groups of three letters—ABC, ACB, BAC, BCA, CAB, and CBA.
The calculation equation is $_3P_3 = 3 \times 2 \times 1 = 6$ (ways).

$n\mathbf{C}r$
This function finds the number of ways of selecting r objects from a set of n objects. For example, from the three letters ABC, there are three ways we can extract groups of two different letters—AB, AC, and CB.
The calculation equation is $_3C_2$.

\<Example\>

Operation	Display
6 [2ndF] $n\mathbf{P}r$ 4 [=]	6P4= DEG 360.
6 [2ndF] $n\mathbf{C}r$ 4 [=]	6C4= DEG 15.

> APPLICATIONS:
> Used in statistics (probability calculations) and in simulation hypotheses in fields such as medicine, pharmaceutics, and physics. Also, can be used to determine the chances of winning in lotteries.

Time Calculation ⇄DEG D°M'S

⇄DEG Converts a sexagesimal value displayed in degrees, minutes, seconds to decimal notation. Also, converts a decimal value to sexagesimal notataion (degrees, minutes, seconds).

D°M'S Inputs values in sexagesimal notation (degrees, minutes, seconds).

\<Example\> Convert 24° 28′ 35″ (24 degrees, 28 minutes, 35 seconds) to decimal notation. Then convert 24.476° to sexagesimal notation.

<u>Operation</u>

24 **D°M'S** 28 **D°M'S** 35

<u>Display</u>

```
                              DEG
          24°28'35
```

2ndF ⇄DEG

Convert to decimal notation

```
                              DEG
   24°28°35.00°    →
    24.47638889
```

2ndF ⇄DEG

```
                              DEG
   24°28°35.00°    →
    24 28'35.00
```

Repeat last key operation to return to the previous display.

```
APPLICATIONS:
Used in calculations of angles and angular velocity in physics, and
latitude and longitude in geography.
```

Fractional Calculations ab/c d/c
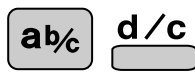
ab/c   Inputs fractions and converts mutually between fractions and decimals.

d/c   Converts between mixed numbers and improper fractions.

<Example> Add $3\dfrac{1}{2}$ and $\dfrac{5}{7}$, and convert to decimal notation.

Operation

Display

3 ab/c 1 ab/c 2 +

5 ab/c 7 =

3⌐1⌐2+5⌐7=
4⌐3⌐ 14.

ab/c

3⌐1⌐2+5⌐7=
4.214285714

Convert to decimal notation
Press once to return to the previous display

2ndF d/c

3⌐1⌐2+5⌐7=
59⌐ 14.

Convert to an improper fraction
Press once to return to the previous display

2ndF d/c

3⌐1⌐2+5⌐7=
4⌐3⌐ 14.

APPLICATIONS:
There is a wide variety of applications for this function because fractions are such a basic part of mathematics. This function is useful for calculations involving electrical circuit resistance.

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Memory Calculations

STO RCL M+
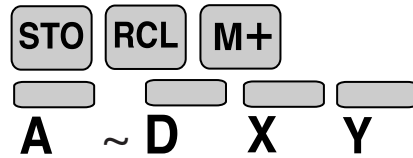
A ~ D X Y

STO — Stores displayed values in memories A~D, X, Y, M.

RCL — Recalls values stored in A~D, X, Y, M.

M+ — Adds the displayed value to the value in the independent memory M.

A ~ D X Y   Temporary memories

<Example>	Operation	Display
	0 STO ☐M (Enter 0 for M)	0 ⇒ M DEG 0.
	25 × 27 M+	25x27M+ DEG M 675.
	7 × 3 M+	7x3M+ DEG M 21.
	RCL ☐M	M= DEG M 696.

Last Answer Memory ANS

ANS   Automatically recalls the last answer calculated by pressing [=]
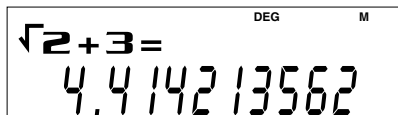
<Example> Solve for x first and then solve for y using x.

$$x = \sqrt{2} + 3 \quad \text{and} \quad y = 4 \div x$$

Operation   Display

[√] 2 [+] 3 [=]

```
√2+3=           DEG      M
    4.414213562
```

4 [÷] [2ndF] ANS [=]
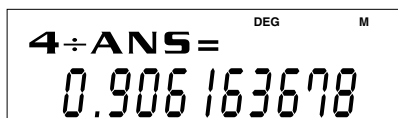
```
4÷ANS=          DEG      M
    0.906163678
```

Trigonometric Functions `sin` `cos` `tan`

Trigonometric functions determine the ratio of three sides
of a right triangle. Combination of three sides are sin, cos,
and tan. Their relations are;
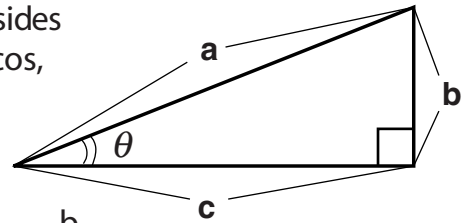
`sin`   Calculates the sine of an angle. $\sin\theta = \dfrac{b}{a}$

`cos`   Calculates the cosine of an angle. $\cos\theta = \dfrac{c}{a}$

`tan`   Calculates the tangent of an angle. $\tan\theta = \dfrac{b}{c}$

<Example>

The angle from a point 15 meters from
a building to the highest floor of the
building is 45°. How tall is the building?
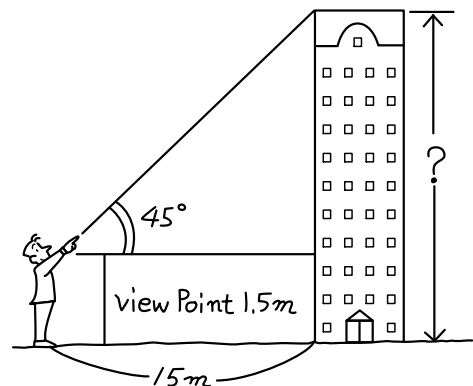
[DEG mode]

Operation

`tan` 45 `×` 15
`+` 1 `•` 5 `=`
View point

Display

tan45x15+1.5 `DEG`

16.5

APPLICATIONS:
Trigonometric functions are useful in mathematics and various engineering
calculations. They are often used in astronomical observations, civil engi-
neering and in calculations involving electrical circuits, as well as in calcula-
tions for physics such as parabolic motion and wave motion.

Arc Trigonometric Functions   sin⁻¹ cos⁻¹ tan⁻¹

Arc trigonometric functions, the inverse of trigonometric functions, are used to determine an angle from ratios of a right triangle. The combinations of the three sides are $\sin^{-1}$, $\cos^{-1}$, and $\tan^{-1}$. Their relations are;
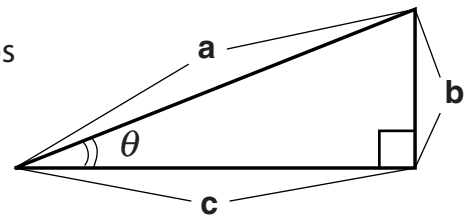
sin⁻¹   (arc sine) Determines an angle based on the ratio b/a of two sides of a right triangle. $\theta = \sin^{-1}\dfrac{b}{a}$

cos⁻¹   (arc cosine) Determines an angle based on the ratio c/a for two sides of a right triangle. $\theta = \cos^{-1}\dfrac{c}{a}$

tan⁻¹   (arc tangent) Determines an angle based on the ratio a/b for two sides of a right triangle. $\theta = \tan^{-1}\dfrac{b}{c}$

<Example>

At what angle should an airplane climb in order to climb 80 meters in 100 meters?

[DEG mode]

Operation	Display

[2ndF] [tan⁻¹] [(] 80 [÷] 100 [)] [=]

```
tan⁻¹(80÷100)        DEG
      38.65980825
```

22
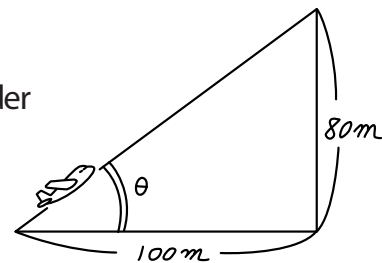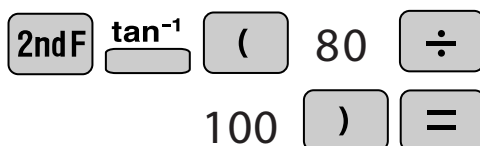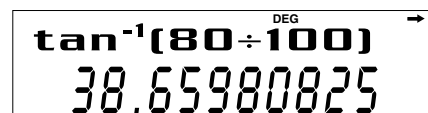
Hyperbolic Functions [hyp] [arc hyp]

For the EL-506R, select sinh, sin^{-1}, cosh, cosh^{-1}, tanh, tanh^{-1} from the MATH key

[hyp]   The hyperbolic function is defined by using natural exponents in trigo-
nometric functions.

[arc hyp]   Arc hyperbolic functions are defined by using natural logarithms in trigono-
metric functions.

> APPLICATIONS:
> Hyperbolic and arc hyperbolic functions are very useful in electrical
> engineering and physics.

Coordinate Conversion →rθ →xy , ←,→

For the EL-506R, select→r, θ and→x, y from the MATH key

→rθ
Converts rectangular coordinates to polar coordinates (x,y →r, θ)

→xy
Converts polar coordinates to rectangular coordinates (r, θ →x, y)

,
Splits data used for dual-variable data input.

←,→
Displays r, θ and x, y. (Cx ⇄ y or r ⇄ θ)

y **Rectangular coordinates**	*y* **Polar coordinates**

y ⌐ P (x,y)

P (r, θ)

r

θ
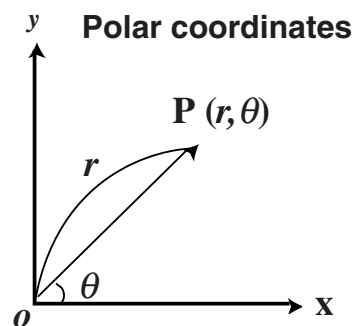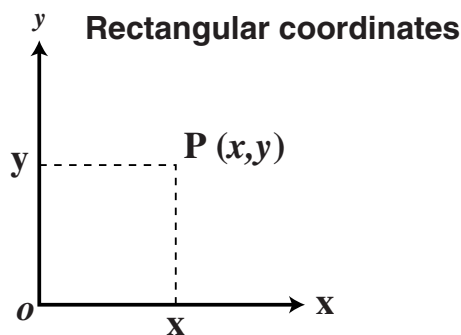
<**Example**> Determine the polar coordinates (r, θ) when the rectangular coordinates of Point P are (x = 7, y = 3).

[DEG mode]

Operation	Display
7 [2ndF] [,] 3 [2ndF] [→rθ]	r = 7.615773106
[2ndF] [←,→]	θ = 23.19859051
7.6 [2ndF] [,] 23.2 [2ndF] [→xy]	x = 6.985428578
[2ndF] [←,→]	y = 2.993958513

Operation example using the EL-531VH/EL-509V

- -
APPLICATIONS:
Coordinate conversion is often used in mathematics and engineering, especially for impedance calculations in electronics and electrical engineering.
- -

Statistics Function

The statistics function is excellent for analyzing qualities of an event. Though primarily used for engineering and mathematics, the function is also applied to nearly all other fields including economics and medicine.

DATA INPUT AND ERASE

Key	Description
DATA	Enters data for statistical calculations.
CD	Clears last data input.
(x,y)	Splits data used for dual-variable data input. (Used for dual-variable statistical calculations.)
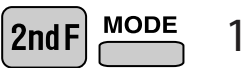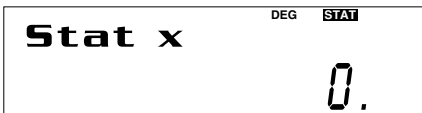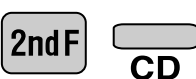
<Example 1> Here is a table of examination results. Input this data for analysis (along with data correction).

Data table 1

No.	1	2	3	4	5	6	7	8
Score	30	40	50	60	70	80	90	100
No. of pupils	2	4	5	7	12	10	8	2

[Select single-variable statistics mode]

Operation	Display
2ndF MODE 1 — Select single-variable statistics mode	Stat x DEG STAT 0.
30 2ndF , 2 DATA	n = DEG STAT 2.
100 2ndF , 5 DATA — In this case, the last data entry has been incorrectly input for the number of pupils.	n = DEG STAT 53.
2ndF CD	n = DEG STAT 48. (final data cleared)
100 , 2 DATA — Score / Number of pupils	n = DEG STAT 50. (correct data input) — Data total up to this point

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"ANS" KEYS FOR 1-VARIABLE STATISTICS

$\bar{x}$

Calculates the average for input data (sample data x).

sx

Calculates the standard deviation of samples from input data (sample data x).

σx

Calculates the standard deviation for a population from input data (sample data x).

n

Displays the number of input data (sample data x).

Σx

Calculates the total for input data (sample data x).

Σx^2

Calculates the total to the second power for input data (sample data x).

NOTE:
1. Sample data refers to data selected randomly from the population.
2. Standard deviation of samples is determined by the sample data shift from an average value.
3. Standard deviation for the population is standard deviation when the sample data is deemed a population (full data).

<Let's check the results based on the previous data.>

| RCL | $\bar{x}$ | 69 (average value) |

| RCL | sx | 17.75686128 (standard deviation) |

| RCL | σx | 17.57839583 (standard deviation of the population) |

| RCL | n | 50 (total count of data) |

| RCL | Σx | 3450 (total) |

APPLICATIONS:
Single-variable statistical calculations are used in a broad range of fields, including engineering, business and economics. They are most often applied to analysis in atmospheric observations and physics experiments, as well as for quality control in factories.

<Example 2> The table below summarizes the dates in April when cherry blossoms bloom, and the average temperature for March in that same area. Determine basic statistical quantities for data X and data Y based on the data table.

<Data table 2>

	Year	1983	1984	1985	1986	1987	1988	1989	1990
x	Average temperature	6.2	7.0	6.8	8.7	7.9	6.5	6.1	8.2
y	Date blossoms bloom	13	9	11	5	7	12	15	7

2ndF	MODE	2		Stat xy DEG STAT
				$0.$

Select dual-variable statistics mode

6	.	2	(x,y)	13	DATA		n = DEG STAT
							$1.$

⋮

6	.	1	(x,y)	15	DATA		n = DEG STAT
							$7.$

8	.	2	(x,y)	7	DATA		n = DEG STAT
							$8.$

Temperature   Date

Data total up to this point

"ANS" KEYS FOR 2-VARIABLE STATISTICS

In addition to the 1-variable statistic keys, the following keys have been added for calculating 2-variable statistics.

Σxy Calculates the sum of the product for sample data X and sample data Y.

Σy Calculates the sum of the data (sample data Y).

Σy² Calculates the sum of the data (sample data Y) raised to the second power.

$\bar{y}$ Calculates the average value of the data (sample data Y).

σy Calculates the standard deviation of a data population (sample data Y).

sy Calculates the standard deviation for the data (sample data Y).

NOTE:
The codes for basic statistical quantities of sample data X and their meanings are the same as those for single-variable statistical calculations.

<Let's check the results based on the previous data.>

RCL $\bar{x}$	7.175	(Average for data X)
RCL sx	0.973579551	(Standard deviation for data X)
RCL σx	0.91070028	(Standard deviation of the population for data X)
RCL $\bar{y}$	9.875	(Average for data Y)
RCL sy	3.440826313	(Standard deviation for data Y)
RCL σy	3.218598297	(Standard deviation of the population for data Y)
RCL n	8	(Total count of data)
RCL Σx	57.4	(Sum of data X)
RCL Σx^2	418.48	(Data X raised to the second power)
RCL Σxy	544.1	(Sum of the product of data X and data Y)
RCL Σy	79	(Sum of data Y)
RCL Σy^2	863	(Data Y raised to the second power)

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